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ABSTRACT

The focus of this curriculum report is on the earth sciences in the K-12 curriculum. High technologies have combined to produce telecommunications, the newest aid and impetus to earth sciences education. Listed in this report are educational service organizations and individual schools that have this service. Included are the names, addresses, and a description of each program. Examples of earth science curriculum programs are also included for both high school and elementary school. The name, address, and a description of each program is listed. (KR)

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Planet Earth's Place in the Educational Sun

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Earth science is taking on a new meaning, a new importance in secondary school curriculum. The changing planet and changing technologies are opening a new world for students.

In Thornton Wilder's *Our Town*, a character tells of a letter her friend received. The envelope was addressed to "Jane Crofut, The Crofut Farm, Grover's Corners, New Hampshire, U.S.A., Continent of North America, Western Hemisphere, The Earth, The Solar System, The Universe, The Mind of God." The detailed address focuses on the recipient's place in the sun.

As students today strive to find *their* place in the sun, a new emphasis on Earth sciences in the K-12 curriculum helps them: Planet Earth, third planet from the sun, has a new place in the educational sun — a new address. Students are mapping *their* neighborhood, national, global, and universal addresses.

The main impulse behind increased emphasis on Earth sciences in the curriculum is to give students an understanding of what is threatening their planet and to arm them with the knowledge to make responsible decisions to protect and save life on the planet. (See NASSP *Curriculum Report*, "Environmental Education: Making the Future More Promising," Jan. 1988.)

Planet Earth has had its place in the sun for about four billion years; in the sun of human art, drama, poetry, and song for three millenia; and in science, starting with astronomy, the oldest science, for a thousand years.

The dawn of the Space Age in 1961 brought Earth sciences into a new place in the educational sun. They have joined the traditional sciences of biology, chemistry, and physics as essential to the academic curriculum.

The advent in the 1960s of the plate tectonic theory — that the Earth's surface consists of a series of slow-moving mobile plates — has also invigorated the Earth sciences established in the nineteenth century as the independent sciences of meteorology, physical geography, geology, and oceanography.

Still another encouragement of a fundamental reappraisal of the importance of Earth sciences is remote-sensing. It is the collecting of data about objects without direct contact. The term is most commonly applied to observations of the Earth's surface from aircraft or satellites, but also to techniques that use electromagnetic radiation rather than methods that measure force fields such as magnetism from a distance.

High technologies have combined to produce the newest aid and impetus to Earth sciences education: telecommunications.

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Telecommunications for Earth Science Students

The National Geographic Society, the American Geological Institute, and the National Science Teachers Association are among the educational service organizations that have brought telecommunications learning aids to the schools.

EDUCATIONAL MEDIA DIVISION, National Geographic Society (NGS), Washington, D.C. 20036. *Contacts:* Dorothy Perreca, NGS Kids Network manager; Lynda de Witt, *The Weather Machine* editor.

The National Geographic Society, chartered as a nonprofit scientific and educational organization, celebrated its 100th birthday on Jan. 13, 1988, when it announced its centennial gift to the nation — $20 million to help teach children about the Earth.

With a membership of 10.5 million and best known for its "flagship," *National Geographic* magazine, the society has supported more than 3,400 explorations and research projects to add to human knowledge of the Earth, sea, and sky.

True to its charter, NGS develops educational media — video disks and cassettes, films, filmstrips, records, magazines, books, maps, computer courseware, and even a board game, Global Pursuit — for elementary school, secondary school, and adult learners in science, geography, and social studies.

Telecommunications projects are the newest of the society's contributions to Earth sciences education. One is the National Geographic Kids Network, through which students nationwide gather scientific data and share them with each other as the result of a four-year collaborative program of NGS and the Technical Education Research Centers (TERC), a nonprofit educational research and development corporation in Cambridge, Mass.

More than 200 schools in the United States and abroad are involved in the information-sharing network after less than two years in operation. In 1989, 4th through 6th graders in 1,000 schools exchanged data about acid rain, climate variations, plant growth, food production, air quality, and even a flu epidemiology study for the Centers for Disease Control. Eventually 10,000 schools may be subscribers.

Another NGS test-site piloted Earth science learning aid is *The Weather Machine Computer Courseware Kit* for grades 7-12. It is designed to teach basic concepts about weather and help pupils make their own weather forecasts. Computer software displays data from the National Weather Service (NWS) in the form of colorful maps of the United States, Canada, and surrounding bodies of water.

Schools that buy the kit have the option of receiving today's weather today through telecommunications. Updated NWS weather information comes into the NGS host computer; a call from a subscriber's computer automatically triggers data transmission from the host computer to the caller's. *The Weather Machine* kit includes three computer disks for the 128k Apple IIe, or IIc, or IIGS; a tutorial on how to use the system, the main program, and an archive data disk of 20 days of weather.

The kit also includes the filmstrip "Looking at Weather," 15 copies of *Forecaster's Handbook,* and a teacher's guide with complete instructional program and activity sheets.

Among the best pilot test sites of *The Weather Machine* were Unionville (Pa.) High School, Earl B. Wood Junior High School in Rockville, Md., and the Ralph Bunch School in New York City. Their exemplary Earth sciences programs are described in this *Curriculum Report.*

AMERICAN GEOLOGICAL INSTITUTE, 4220 King St., Alexandria, Va. 22302. *Contacts:* Marvin Kauffman, executive director; Andrew Verdon, Jr., educational director.

NATIONAL SCIENCE TEACHERS ASSOCIATION, 1742 Connecticut Ave., N.W., Washington, D.C. 20009. *Contacts:* Bill Aldridge, executive director; Merilee DeWall, publications.

Earth Science Electronic Exchange Network (ESEENET) is a pilot program developed for Earth science students and teachers and introduced at the National Science Teachers Association (NSTA) 1988 convention in St. Louis. The pilot program is sponsored by the National Center for Earth Science Education of the American Geological Institute, in cooperation with NSTA and will be used as a telecommunication base.

ESEENET has the following functions:

- Main Message Base — a forum for educators and others interested in Earth science instruction
- Student Message Base — for Earth science students to use to exchange data
- Real Time Data — to provide weekly, updated information from governmental and other agencies about earthquakes, weather, and other Earth phenomena
- Lab Activities — developed by teachers and capable of being downloaded and updated regularly with new activities
- Scientist Interaction — to enable students and teachers to correspond with scientists working on projects such as NASA's, who exchange information on other bulletin board systems
- Data Base — to provide all ESEENET users with references.

ESEENET is one of many services to schools by the American Geological Institute, whose conference of Geoscientists and Educators to Plan Curriculum Content Regarding Planet Earth was held April 19-22, 1988, in Alexandria, Va.

One of the speakers was Dr. E. Johns Dasch, whose stimulating and famous Rocks and Stars course since 1981 has attracted enrollment of 10 percent of the student body at Oregon State University. "What should high school graduates know about Earth science?" he asked.

"They should know — be aware — that it is as tremendous as it really is," he responded to his own question. They should be aware that the field is exciting, an integrated "bundle" of natural, descriptive, analytical, experimental, and theoretical sciences. They should be aware that it is concerned with what we need from Earth, how to get it, and to live with what's left.

Richard S. Williams, Jr., of the U.S. Geological Survey (USGS) in Reston, Va., who discussed "Global Change in the Geosphere" at the conference, predicted a quickening approach to an acceleration of change on the surface of the Earth in response to human activity. Needed is a scientifically literate citizenry to make wise decisions to deal with these changes. Only Earth science can give students a cohesive, global perspective of the complex interrelationships of the geosphere and biosphere.

Susan E. Humphris, representing the Sea Education Association at Woods Hole, Mass., recommended to the educators at the conference that a curriculum in oceanography should enable students to answer such questions as: How can human beings make use of the oceanic environment? What effects can they have on that environment? Positive effects include management of fisheries, legislation to protect mammals, prohibition of dumping. Negative effects are pollution by oil, by plastics, by sewage.

Exempli Gratia

FAIRFAX COUNTY PUBLIC SCHOOLS, Department of Instructional Services, The Donald Lacey Instructional Center, 3705 Crest Dr., Annandale, Va. 22003. *Contact:* Ms. Johnnie Hamilton, science coordinator.

Fairfax County, Va., schools have one of the most updated, forward-looking Earth science curricula in the nation. Rocks and Charts (geology) is a 4th grade unit of Earth sciences that involves pupils in close examination of 21 rocks and minerals. Pupils record their observations of texture, colors, and other characteristics and then devise a classification system of density, crystalline structure hardness, magnetic attraction, luster, electrical conductivity, and reaction to weak acids.

A unique feature of the 4th, 5th, and 6th grade astronomy units is visits to one of the school system's nine planetariums, which provide pupils the opportunity to study the night sky during daylight and record observational data to use on return to the classroom laboratory.

The Sun and Its Neighbors unit introduces 4th graders to the planetarium equipment, the sun, and the planets.

In Stars and Constellations, 5th graders observe and study seasonal and polar constellations, investigate the diurnal motion of the sun and stars, and locate the visible planets. Exploring the Universe enables 6th graders to study the moon and its phases, lunar and solar eclipses, and a variety of galaxies.

Using a multi-media program of videotapes, software modules, and printed materials, 7th graders take at least one semester of the required course, Investigations in Environmental Science, which includes the units Organisms and Populations and Communities and Ecosystems. The full-year option is a second semester with the modules People and Their Environment and Environmental Factors, involving the nature of pollution, water quality, energy, and resource recovery.

Earth Science, Earth Science (GTP), and Earth and Space Science are one-semester choices for grade 9 students. Earth Science (GTP) is designed to meet the needs of gifted and talented students. Earth and Space Science (open to 10th as well as 9th graders) is for students whose previous scholastic record and diagnostic test scores indicate deficiencies in reading and mathematics skills.

All three courses incorporate studies of astronomy, physical geography, meteorology, and oceanography. The basal text is *Earth Science* (Scott Foresman, 1983). An additional text is *Resource Guide for Earth Science Teachers*, an 896-page tome, prepared by the schools' Department of Instructional Services, complete with syllabi, lesson plans, student laboratory hands-on activities, aims, purposes, and resources.

Three elective one-semester courses in advanced Earth sciences, with a prerequisite of algebra 2 and two years of laboratory science, are offered high school juniors and seniors:

- Geology has a corequisite of physics 1 and deals with Earth chemistry, Earth materials, plate tectonics, weathering and erosion, mountain building, volcanism, and Earth history.
- Oceanography, also with a physics 1 corequisite, deals with the geology and geography of ocean basins, physical properties of sea water, marine chemistry and biology, salinity and density circulation of oceans, waves, and tides; and oceanography instruments, tools, and methods.
- Astronomy, whose corequisites are physics 1 and trigonometry, provides a more in-depth and mathematical treatment than the astronomy concepts of 9th grade Earth science. The universe, universal laws, galaxies, stellar evolution, the solar system and its motion, and the exploration of space constitute the course, which includes frequent use of the planetariums.

Fairfax County science teachers are equipped with detailed classroom, laboratory, equipment, and materials safety regulations. In the code is "Special Considerations for Earth Science," which embody rules regarding mechanical hazards, rocketry, electrical hazards, chemical hazards, light hazards, eclipse watching, and sunplate observation.

HERNDON HIGH SCHOOL, 700 Bennett St., Herndon, Va. 22070. *Contacts:* William Trussell, Jr., principal; Eugenie Lankford, Earth sciences teacher.

Since Herndon High School, a Fairfax County school, opened 20 years ago, it has offered a strong program in Earth sciences, mainly because its sequence of courses starts in 9th grade. Of 2,222 students in grades 9-12 during the 1987-88 school year, 49 selected Senior Earth science or anatomy, 11th and 12th grade electives.

Of the 587 freshmen, 428 or 74 percent were enrolled in the three 9th grade courses, Earth science, Earth science (GTP), and Earth and space science.

Prerequisite for the advanced anatomy elective are algebra 2 and two years of laboratory science; co-requisites are physics 1 and trigonometry.

Herndon is fortunate to have a planetarium in the building and a planetarium director. The 9th grade Earth science classes and the senior Earth science class have three to five observations a year, and astronomy students observe three to five times a month.

Earth science teachers at Herndon are committed to the advancement of their curriculum. They work together to be informed and share materials and ideas. They work with the USGS and NASA to bring the most up-to-date information to the students. Each is highly qualified as an Earth science specialist; two have advanced degrees in the subject. Two are honors teachers selected by NASA as NEWMAST teachers.

EARL B. WOOD MID-LEVEL SCHOOL, 14615 Bauer Dr., Rockville, Md. 20853. *Contact:* Richard A. Knight, science teacher.

Serving a multi-ethnic community, this grade 6-8 school for 770 students offers Earth science under the title of general science, a two-semester course for 8th graders. It is taught as a hands-on, activity based curriculum. The activities demonstrate a strong emphasis on expecting the students to learn the process of science with reduced emphasis on the learning of content facts.

The philosophy is that students should spend a majority of their time learning how to investigate, interpreting what was investigated, and applying it to that which is being studied.

Units are Astronomy, Rocks and Minerals, Weather and Climate, Oceanography, Earth Processes, and Earth History.

UNIONVILLE HIGH SCHOOL, Route 82, Unionville, Pa. 19375. *Contacts:* John Maher, principal; Helen E. Martin, teacher of science and mathematics.

Unionville High has its own Weather Satellite Tracking Station, built by 56 students five years ago. Their teacher, Helen Martin, used as a resource for their project, R.J. Summers' *Teachers Guide for Building and Operating Weather Satellite Ground Stations for High School Science* (Greenbelt, Md.: Goddard Space Flight Center, 1981). The 85-page book, edited and updated the summer of 1988, is available for a minimal price, through either Helen Martin or William Torop, West Chester University, West Chester, Pa. 19383.

Martin teaches the elective two-semester courses, Earth and space science, level I, grades 11 and 12; and Earth and space science, level II, grade 12.

Level I integrates throughout its units the theme, "Thinking as a Scientist and Exploring the Relationship of Technology to Society." Using computers, the weather station, ham radios, radio telescopes, seismometry, recording instruments, and lapidary equipment, students study nine weeks each of meteorology, geology, astronomy, and oceanography.

Earth and space science, level II, is a special problems course that enhances students' skills developed in Level I and enables pursuit of a specific topic decided by each student with the teacher. Students are integrated into the schedules of the level I sections and serve as student leaders, instructors, and lab assistants.

Detailed syllabi of the two courses, copies of Martin's Jan. 1987 *The Science Teacher* article about the program, and a brochure about the Weather Satellite Tracking Station are available at no charge from her at Unionville High.

For $10, a 10-minute video about the satellite project is available. For $5, a student-developed software disk for the Apple IIe to calculate the predicted data for polar orbiting satellites, is available.

THE RALPH BUNCHE SCHOOL, P.S., 125, 433 West 123 St., New York, N.Y. 10027. *Contact:* Paul A. Reese, computer coordinator teacher.

With a student body of 600 3rd through 6th graders, 65 percent of whom are black and 30 percent Hispanic, the Ralph Bunche School is one of two schools in collaboration with Bank Street College. In the Central Harlem, Bunche School is a 1987 Apple Corporation "Equal Time" awardee. It was also initiator of the project, Earth Lab, to improve science and literacy instruction by providing a model for integrating communication skills into science instruction.

Using Apple IIe and IIGS computers, 5th and 6th graders study Earth science with the help of a Corvus local-area network, specific software, a database program, word processor, schoolwide electronic mail telecommunication, and interactive simulation.

Pupils master important concepts, develop problem-solving skills, and skills for systematic analysis for data; gain an understanding of how scientists work, collaborate, and communicate; understand that scientific problems are embedded in real-life situations; and enjoy science and desire to continue its study.

BRONX HIGH SCHOOL OF SCIENCE, 75 West 205 St., Bronx, N.Y. 10468. *Contacts:* Milton Kopelman, principal; Jack Kligman, assistant principal.

Under the auspices of the physical sciences department, two-year-long Earth science offerings of the Bronx High School of Science are astronomy and astrophysics — six periods a week with college credit available; and geology, meteorology, and oceanography — five periods a week.

Using Pasachoff's *Contemporary Astronomy* and Abell's *Exploration of the Universe*, the astronomy and astrophysics course explores such topics as origins and

early development of astronomy; basic concepts and the celestial sphere; celestial coordinates: horizon and equator systems; structure and motions of the Earth and its orbit; the study of time, development of the calendar; also, principles of optics, phenomena of light, optical instruments, telescopes and image utilization; and eclipses and tides.

With Foster's *Physical Geography* and Gross' *Oceanography* as resources, the syllabus of geology, meteorology, and oceanography includes minerals, volcanoes and igneous rocks, weathering and soil, sedimentary and metamorphic rocks, topographic mapping, and hillside erosion; rivers/lakes, ground water/caves, alpine and continental glaciation, deserts and arid areas; earthquakes and the Earth's interior, mountain building, and geologic time. Students also study topics in meteorology and oceanography.

GREAT NECK NORTH HIGH SCHOOL, 35 Polo Rd., Great Neck, N.Y. 11023. *Contacts:* Carol Clarke, principal; Carol L. Mitch, science department head.

For more than a quarter-century, this Long Island senior high school (grades 9-12) has required freshman Earth science for graduation. Since 1980, 9th graders have been able to choose between Earth science Regents or Earth science general, each a two-semester course.

While New York State does not mandate Earth science in high school, it does require that the 7-9 curriculum include the Earth sciences. Ten years ago Great Neck North High decided the standard course for average 9th graders would be Earth science Regents. Middle school students now cover the state curricula in life sciences and physical sciences, but Earth science Regents is offered to above-average, accelerated 8th grade students.

Earth science Regents follows the New York State Regents Earth science syllabus, supplied by the state education department, bureau of science education. The major units of the course include Observation and Measurement of the Environment, The Changing Environment, Measuring the Earth, Earth Motions, Energy in Earth Processes, Insolation and the Earth's Surface, Energy Exchanges in the Atmosphere, Moisture and Energy Budgets and Environment Change, and The Erosional Process.

The current text for the course is *Earth Science, A Study of a Changing Planet* by Robert B. Daley, W. John Higham, and George F. Matthias (Mass.: Cebco, 1986). The lab manual is *Observation and Interpretation in Earth Science* by David Berey and others, also a Cebco publication (1972). The syllabus uses 16mm films, videotapes, slides, and other audiovisual materials.

The text for the other 9th grade course, Earth science general, is *Earth Science* by William L. Ramsey et al. (New York: Holt, Rinehart and Winston, 1986). The syllabus is provided by the New York State Department of Education for the 7-8-9 blocks that deal with the Earth sciences. Major areas include The Earth's Changing Surface, Weather and Climate, and Astronomy and Aerospace Science. In addition, topics of local interest such as the geology and Earth history of Long Island, receive special attention.

BEVERLY HILLS HIGH SCHOOL, 241 Mareno Dr., Beverly Hills, Calif. 90212. *Contact:* Sol Levine, principal.

Because of the unique nature of Beverly Hills and the upper socioeconomic community its high school serves, the student body of 2,300 in grades 9-12 is very cosmopolitan.

Their full year astronomy course — for all grades — has been popular and successful since its inception, coincident with the opening of the district's 85-seat planetarium in 1969. Five sections of astronomy are offered as a course that satisfies state requirements.

Astronomy is comprehensive, including the historical views of the solar system and the universe, the night sky and constellation identification, star formation, sky objects, galaxies, and the structure of the universe. Covered in the second semester are cosmology, the sun and the planets, life in the universe, space travel, telescopes, and current events.

The concept of the Earth as an object in space that is both simply a place in the universe but also special and unique in its diversity is stressed. Study of the solar system with terrestrial analogies that assist the students in gaining a personal sense of what these other "places" are really like is also included.

Indispensable in the study of comparative planetology are the resources of the U.S. Geological Survey which are used extensively in the course. The USGS publishes topographic, geologic, and photographic maps of all the planets that have been visited by spacecraft. It also publishes satellite photographs of the Earth that are inexpensive and strikingly beautiful. USGS offices are located in many large cities. Or, materials can be ordered directly through USGS, Reston, Va. 22092.

J.C. BOOTH JUNIOR HIGH SCHOOL, 250 Peachtree Parkway S., Peachtree City, Ga. 30269. *Contact:* Sara Goza, principal.

Planet Earth's place in the solar system is a popular concern for Booth Junior High's pupils, parents, principal, teachers, and the Peachtree City Police Department.

In 8th grade, pupils of the 7-8-9 grades school take Earth science for two semesters. During the winter they study astronomy, their favorite unit. Their course also covers geology, oceanography, and meteorology.

Using a portable planetarium, STARLAB, owned by the school district, students identify star constellations and then participate in at least one Night Lab. To prepare for Night Lab, the school purchases a Celestron telescope. With the help of astronomers at Atlanta's Fernbank Planetarium several pilots, and *Astronomy* magazine, three Night Labs were established. One lab studied fall and polar constellations; another, planetary objects; and the third introduced a study of the moon.

The Peachtree Police Department helped with the mechanics of the Night Lab, which required a dark but safe area for observations. The labs became a family af-

fair, for most parents would observe with the students and teachers.

"However," said principal Sara Goza, "the most enthusiastic observers we had were the policemen. These labs brought out other amateur backyard observers."

The Night Labs, stimulating greater student interest at the school, caused expansion of student science clubs — Science Club for general scientific interest, Astronaut Club to emphasize aeronautics and space science, and Science Olympiad Scholars Club.

The goals of the clubs are to provide field trips — local visits to the Air Traffic Control Center, factories, and gold-mining in the north Georgia mountains. Students also go on overnight trips to Huntsville, EPCOT, Cape Kennedy, Sea World, Jekyll Island Marine Studies, and primitive camping in the Smoky Mountains. Another goal is to stimulate individual growth in science by opportunities such as a scholarship to Space Camp in Huntsville.

Three Booth Junior High publications are available from the school for $1 to cover the cost of postage: "General Guidelines for Conducting Night Labs," which includes a resource list of 9 Georgia planetariums and 10 Georgia space museums; "Night Astronomy Lab: Moon Observation"; and "Night Astronomy Lab: Autumn Sky."

THE NORTH CAROLINA SCHOOL OF SCIENCE AND MATHEMATICS, P.O. Box 2418, 1219 Broad St., Durham, N.C. 27705. *Contact:* William Youngblood, principal.

This highly specialized school for 470 gifted math and science 11th and 12th graders offers a choice of astronomy or astrophysics, one-semester courses, each designed for both juniors and seniors.

Astronomy has a corequisite of either physics or physics and topics. The course emphasizes the origin and evolution of the planets, stars, galaxies, and the universe without going into mathematical detail. Students are able to gain proficiency in the operation of the school's telescopes in the process of studying the motions of the sun, moon, and planets through the stars.

Astrophysics has a co-requisite of either physics or physics and topics plus, algebra 2/introduction to college mathematics or higher mathematics courses. Covering the same topics as astronomy, astrophysics involves more mathematics and more rigorous physical and chemical techniques integrated into the study of stellar and galactic structure and evolution. Students have the option of pursuing theoretical (including computer oriented) projects and/or observational (telescopic) projects.

Both courses use Kaufman's *Universe* as text and the following syllabus: Spectroscopy, Stellar Structure and Evolution, Galactic Structure and Evolution, and The Universe.

Kudos

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